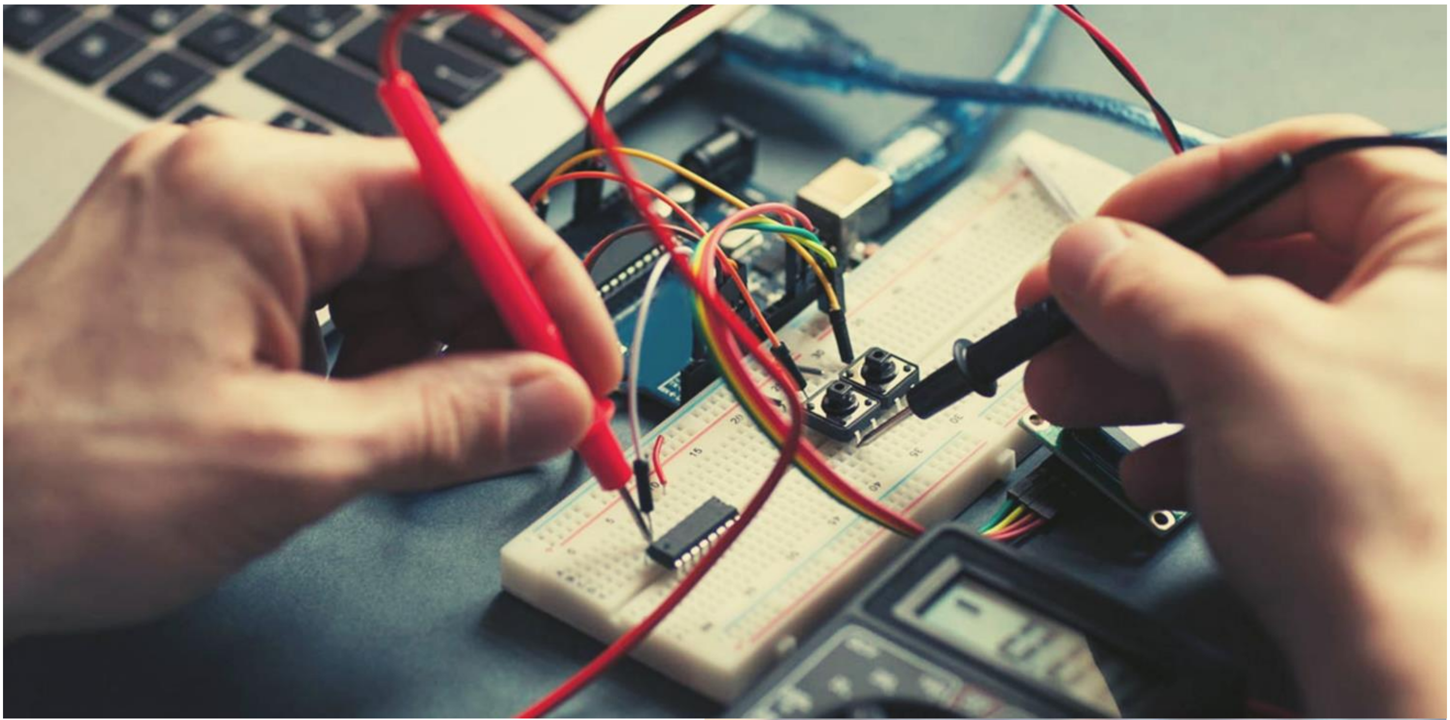
POLITEKNIK MALAYSIA
TUN SYED NASIR

DGI20053
ELECTRONICS



LABORATORY
PROCEDURES e-BOOK

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Preface

Laboratory Procedure eBook is the result of a new alternative for the course of DGI20053 Electronics. It is written for the use of student references to undergo practical which is in line with today's technological advances and educational demands that are global in nature. This eBook fits the current learning style of mobility where learning can take place anywhere and at any time is not limited to a particular location. This eBook is based on the syllabus developed by the Curriculum Division of Polytechnic Studies Division and Community College and is suitable for the courses offered. It is hoped that this eBook will be able to contribute in achieving the course learning outcomes of DGI20053 Electronics course.

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EXPERIMENT : **1**

TITLE : **P-N TYPE BIASING**

OBJECTIVES : At the end of this experiment, students should be able to

i) give basic knowledge about diode and their functions.

ii) give knowledge about the usage ammeter and its functions.

iii) give knowledge about the usage voltmeter and its functions.

iv) learn how to read the scale on ammeter and voltmeter.

EQUIPMENT/COMPONENT:

i. Diode IN 4001, IN 4002 & Diode Zener
ii. Resistor 1kΩ
iii. Power Supply 9V
iv. Jumper / Crocodile Clip
v. LED
vi. Multimeter

THEORY

Semiconductors are solid whose resistivity lies between those of electrical conductors and insulators. Transistors, junction diodes, Zener diodes, tunnel diodes, integrated circuits and metallic rectifiers are example of semiconductors. Semiconductors are used in computers, in radio, and television receivers, in video cassette recorders and other electronic products.

Semiconductors devices performs many control functions, they may use as amplifiers, rectifiers, detectors, oscillators and switching elements.

Diode is an active component that can produce voltage and current signal. The positive terminal is called the anode and the negative terminal is called the cathode as shown in Figure 1.1. It consists of 2 parts P and N junction which cannot be seen by naked eyes. These parts were made by a process called Doping. This component has an unique characteristics the ability to pass current readily in one direction.

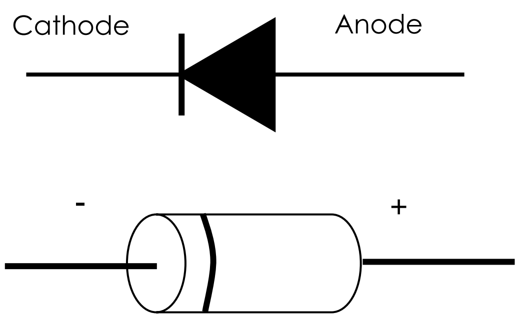

Figure 1.1: Diode

Connection of the negative battery terminal to the N-type and the positive battery terminal to the P-type silicon results in current flow and is called *forward bias*. Electrons and holes are repelled toward the PN-junction, where they recombine to from neutral charges and replaced by free electrons (negative charges) from the battery. This movement of charges maintains a high forward current through the diode in the form of free electrons passing from the N material through the junction and the P material, towards the positive terminal of the battery. Because current flows in this connection, the diode is said to have a *low forward resistance*.

SECTION A: DIODE TESTING

PROCEDURE

1. Identify anode terminal and cathode terminal.
2. Set the multimeter to OHM Range. Choose a suitable scale range.
3. **Swap positive probe (red) ⇔ negative probe (black). This procedure due to battery polarity in multimeter**

4. Touch positive probe to anode and negative probe to cathode.
5. Take reading from multimeter and refer to the table below.
6. Fill your answer in **Table A.**

Type of bias	Procedure
Forward bias	When the positive probe at anode terminal and the negative probe at cathode terminal, it will show a **low resistance**.
Reverse bias	When the negative probe at anode terminal and the positive probe at cathode terminal, it will show a **high resistance (∞).**

SECTION B: THE CHARACTERISTIC OF DIODE

PROCEDURE.

1. Connect the circuit as shown in **Figure 1.2** below.

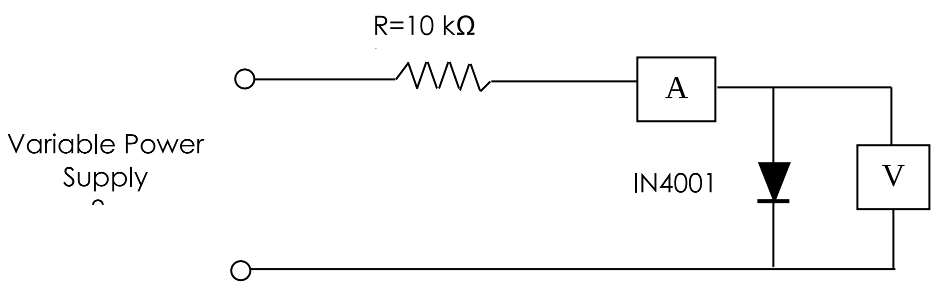

Figure 1.2

2. Set the power supply from to 9V.
3. On the power supply and measure the voltage drop of resistor (V_R), diode (V_D) and current (I).
4. Change the value of resistor to 100 kΩ and get the voltage drop of resistor (V_R), diode (V_D) and current (I).
5. Record the meter reading in **Table B.**
6. Reverse the diode connection and repeat steps 1 to 5.

SECTION C: FORWARD / REVERSE BIAS DIODE WITH THE LED

PROCEDURE.

I) Forward Bias with LED as indicator

1. Connect the circuit as shown in **Figure 1.3.**

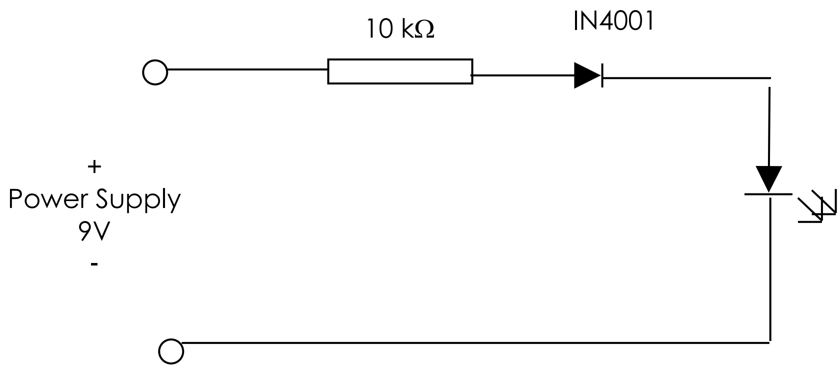

Figure 1.3

2. Set the power supply to 9V.
3. On the power supply.
4. Fill your answer in **Table C**

II) Reverse Bias with LED as indicator

1. Connect the circuit as shown in figure below **Figure 1.4.**

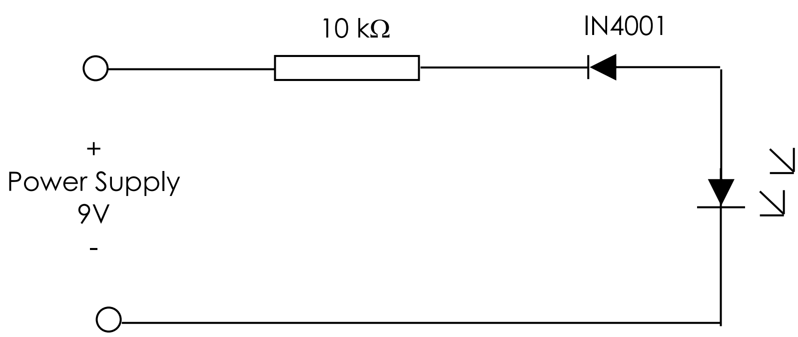

Figure 1.4

2. Set the power supply to 9v.
3. On the power supply. Fill your answer in **Table C.**

RESULT

Table A

Type of diode	Diode	Resistance value	Type of bias
IN 4001	**A** — **K** Red Black		
	A — **K** Black Red		
IN 4002	**A** — **K** Red Black		
	A — **K** Black Red		
5.6 V 400 mW (ZENER DIODE)	**A** — **K** Red Black		
	A — **K** Black Red		

Table B

R	BIAS	V_R	V_D	I measure	I calculation
10 KΩ	Forward				
	Reverse				
100 KΩ	Forward				
	Reverse				

Table C

DIODE CONDITION	LED (ON/OFF)
FORWARD BIAS	
REVERSE BIAS	

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EXPERIMENT : **2**

TITLE : **HALF WAVE RECTIFIER**

OBJECTIVES : At the end of this experiment, students should be able to

i) design and simulate a Half Wave Rectifier circuit by using the Proteus/ Live Wire.

ii) take the reading and draw the input and output waveform.

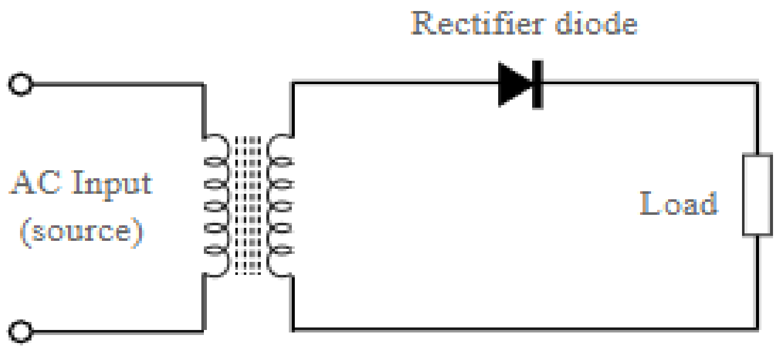
iii) Learn how to build rectifier circuit on breadboard. s.

iv) give knowledge about the operation of half wave rectifier through the measured output voltage.

EQUIPMENT/COMPONENT: Proteus/ Live Wire Software (Circuit Simulation)

THEORY

The conversion of AC into DC is called Rectification. In other words, a **rectifier** is an electrical device that converts alternating current (AC) to direct current (DC). In half wave rectification, either the positive or negative half of the AC wave is passed, while the other half is blocked. The operation of Half Wave Rectifier, during the positive half cycle, the diode is forward biased, and it conducts and hence a current flow through the load resistor. During the negative half cycle, the diode is reverse biased, and it is equivalent to an open circuit, hence the current through the load resistance is zero. Thus, the diode conducts only for one half cycle and results in half wave rectification.



Circuit diagram of Half Wave Rectifier Circuit

PROCEDURE: DESIGN AND SIMULATE WAVE RECTIFIER

Circuit simulation in Proteus begin by placing or drawing the schematic diagram into the Multisim environment.

Section A: Half Wave Rectifier

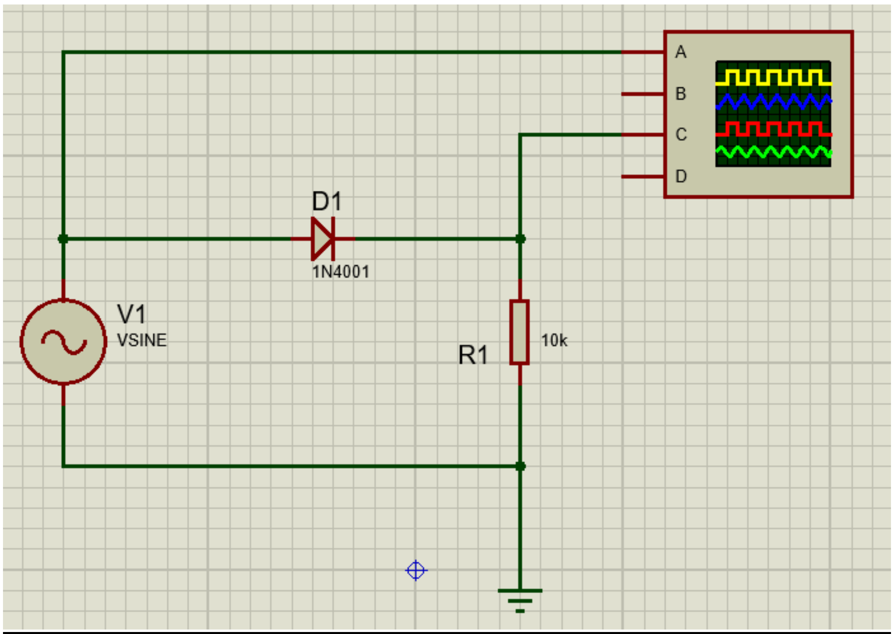


Figure 1: Half Wave Rectifier Circuit Using Proteus

1. Open the Proteus Design Suite Application
2. Click “New Project” and write down project name. Click Next.
3. Choose “Create a schematic from the selected templates”. Choose Landscape A4. Click Next
4. Choose “Do Not Create PCB Layout”. Click Next
5. Choose “No firmware project”. Click Next
6. Click Finish
7. The appearance will show the schematic board of Proteus.
8. Type component keyword to search for the components
   Example “VSINE” as a Sine Wave AC Voltage Source.
9. Double click to place the components
10. Search the next components and repeat procedure no 9 until all the components needed have been searched.
11. Start placing components on the schematic board by referring to the Figure 1.
12. Start connecting the wires.
13. Edit the components for VSINE by double click on the component. Setting the Amplitude and Frequency.
14. Choose “Terminals” menu to place ground on circuit
15. Choose “Measure” menu. Place the Oscilloscope at the load to show the output of the rectifier.
16. To simulate click Play.
17. The output for a Half Wave Rectifier will appear on the oscilloscope
18. Record the result on the Table 1.

RESULT:

Table 1

VOLTAGE & FREQUENCY	WAVEFORM (THEORY)	WAVEFORM (HALF-WAVE RECTIFIER) SIMULATION
Input : ______ Frequency : ______		
Output : ______ Frequency : ______		

<u>Section B : Full Wave Rectifier</u>

1. Repeat the procedure 1 through 10 as above.
2. Start placing components on the schematic board by referring to the Figure 2.
3. Start connecting the wires.
4. Simulate the circuit and explain the result

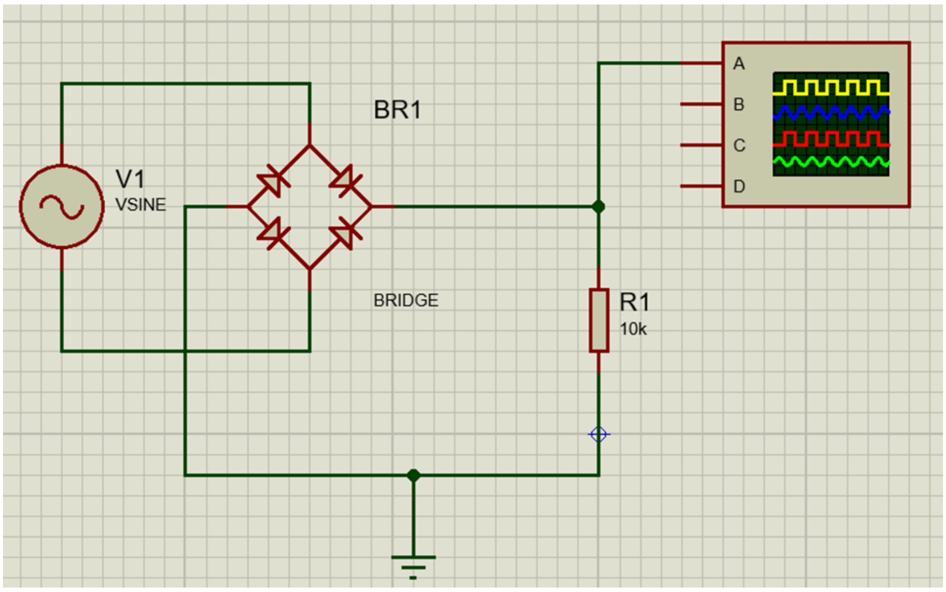


Figure 2: Full Wave Rectifier Circuit Using Proteus

Output Waveform

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EXPERIMENT : **3**

TITLE : **TRANSISTOR TESTING**

OBJECTIVES : At the end of this experiment, students should be able to:

i) Determine the leads of transistors by using ohmmeter and type of transistor NPN or PNP.
ii) Measure the forward and reverse bias resistance of the collector- base and emitter-base junction.
iii) Measure currents and voltages for transistor as a switch.

EQUIPMENT/COMPONENT :

i) Transistors (NPN-2N 2222, BC 548, BC 107 & BC 108)
ii) Jumper Wire
iii) Breadboard

THEORY

The transistor is small and light, permitting miniaturization of electronic equipment. Transistor can operate with the low supply voltage and made from two types of material, germanium and silicon. There are two types of standard transistors, NPN and PNP, with different circuit symbols. The letters refer to the layers of semiconductor material used to make the transistor. Most transistors used today are NPN because this is the easiest type to make from silicon. The leads are label as base (B), collector (C) and emitter (E).

1.0 Testing a transistor

An ohmmeter can also be used to determine the leads (base, collector and emitter) of a transistor. This determination can also be made by simply looking at the orientation of the leads on the casing (see Figure 3.3). For an NPN transistor, the forward-biased junction from base to emitter (see Figure 3.1) and result in a reading that will typically fall in the range of 100 Ω to a few kilohms. The reverse-biased base to collector junction (see Figure 3.2) with a reading typically exceeding 100 kΩ. For a PNP transistor the leads are reversed for each junction. Obviously, a large or small resistance in both directions (reversing the leads) for either junction of a npn or pnp transistor indicates a faulty device.

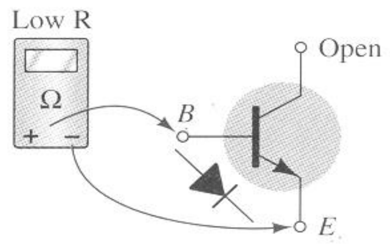


Figure 3.1

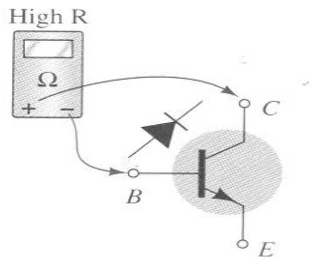


Figure 3.2

2.0 Transistor codes

There are three main series of transistor codes used in the UK as shown in Figure 5.2:

- **Codes beginning with B (or A), for example BC108, BC478**
  The first letter B is for silicon, A is for germanium (rarely used now). The second letter indicates the type; for example, C means low power audio frequency; D means high power audio frequency; F means low power high frequency.
- **Codes beginning with TIP, for example TIP31A**
  TIP refers to the manufacturer: Texas Instruments Power transistor. Odd numbers are NPN, even numbers are PNP. The letter at the end identifies versions with different voltage ratings.
- **Codes beginning with 2N, for example 2N3053**
  The initial '2N' identifies the part as a transistor and the rest of the code identifies the transistor. There is no obvious logic to the numbering system.

REMINDER

Exchange multimeter probe before testing the transistor due to battery polarity.

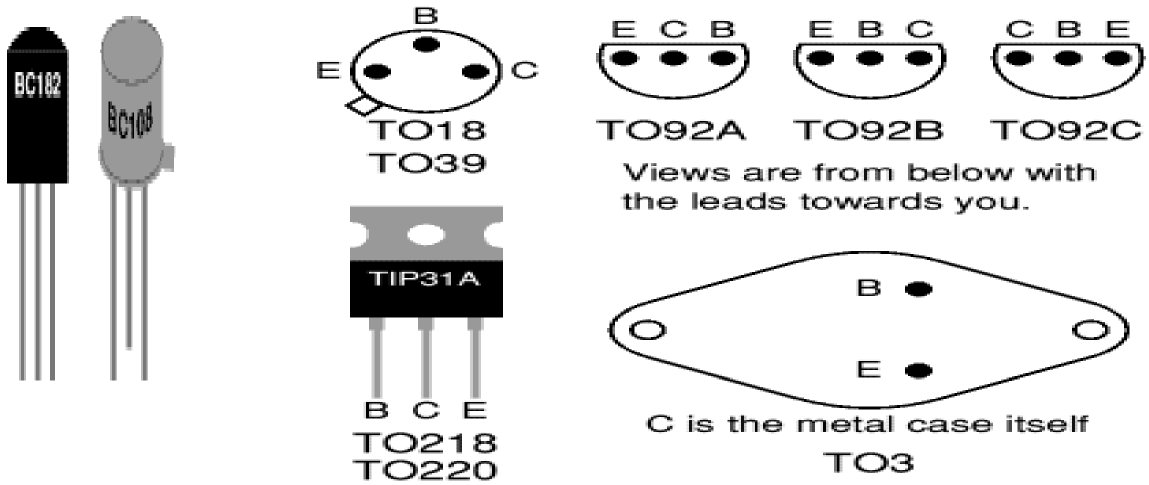


Figure 3.3: Types of transistors

SECTION A: TRANSISTOR LEAD DETERMINATION

PROCEDURE

To determine BASE terminal

1. Set ohmmeter range to 1 Ω.
2. Find two terminals of which record low resistance value.
3. The base terminal is the one excluded in two above.
4. Record your answer in **Table 3.1**.

To determine NPN / PNP types

1. Connect one probe to the base terminal and another probe to other terminal.
2. A PNP transistor is recognized when low resistance is recorded while the black probe is connected to the base terminal
3. A NPN transistor is recognized when low resistance is recorded while the red probe is connected to the base terminal.
4. Record your answer in **Table 3.1**.
5.

To determine COLLECTOR and EMITTER terminal

1. Set ohmmeter range to 10 kΩ.
2. Excluding the base, connect the two probes to the terminals
3. Find a low resistance reading.
4. For a NPN transistor, the emitter is at the red probe.
5. For a PNP transistor, the emitter is at the black probe.
6. Record your answer in **Table 3.1**.

SECTION B: TRANSISTOR REVERSE/FORWARD BIAS TESTING

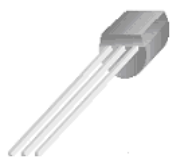
PROCEDURE

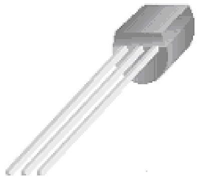
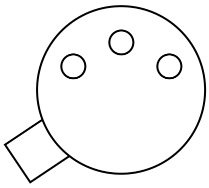
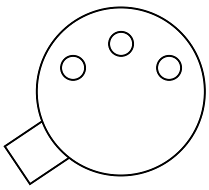
1. Set ohmmeter scale to 100 Ω.
2. Check resistance value at junction B-E. Write down your reading into **Table 3.1**.
3. Set ohmmeter scale to 100 Ω.
4. Check resistance value at junction B-C. Write down your reading into **Table 3.1**.
5. Repeat the procedure to each transistor

RESULT

SECTION A & B: Transistor Lead Determination & Transistor Reverse/Forward Bias Testing

Table 3.1.

Transistors	Lead Identification (By Drawing)	Reversed Bias / Forward Bias Testing
 TR CODE: **BC 548**		**1. Terminal B-E:** Type of Bias:…………………… Resistance value :…………Ω **2. Terminal B-C:** Type of Bias:…………………… Resistance value :…………Ω

 TR CODE: **2N 2222**		**1. Terminal B-E:** Type of Bias:…………………… Resistance value :…………Ω **2. Terminal B-C:** Type of Bias:…………………… Resistance value :…………Ω
 TR CODE: **BC 107**		**1. Terminal B-E:** Type of Bias:…………………… Resistance value :…………Ω **2. Terminal B-C:** Type of Bias:…………………… Resistance value :…………Ω
 TR CODE: **BC 108**		**1. Terminal B-E:** Type of Bias:…………………… Resistance value :…………Ω **2. Terminal B-C:** Type of Bias:…………………… Resistance value :…………Ω

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EXPERIMENT **: 4**

TITLE **:** The output characteristics of CE (common emitter) configuration of BJT.

Objective : Study of the output characteristics of CE (common emitter) configuration of BJT.

Apparatus: Personal Computer (PC), Proteus (ISIS) Professional 8, Graph paper

Theory :

Unlike the diode, which has two doped regions, a transistor has three doped regions. They are as follows –

a) Emitter,
b) Base and
c) Collector.

These three doped regions form two junctions: One between the emitter and base and other between the collector and the base. Because of these it can be thought as combination of two diodes, the emitter and the base form one diode and the collector and base form another diode. The emitter is heavily doped. Its job is to emit or inject free majority carrier (electron for NPN and hole for PNP) into the base. The base is lightly doped and very thin. It passes most of the emitter-injected electron (for NPN) into the collector. The doping level of the collector is between emitter and base. Figure 4.1 shows the biased NPN transistor.

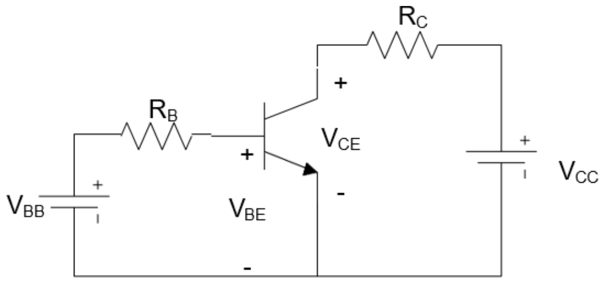

Figure 4.1: Biasing of

If the VBB is greater than the barrier potential, emitter electron will enter base region. The free electron can flow either into the base or into the collector. As base lightly doped and thin, most of the free electron will enter into the collector. There are three different current in a transistor. They are emitter current (IE), collector current (IC) and the base current (IB) are shows in figure 4.2.

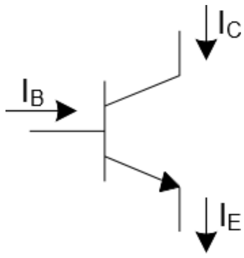

Figure 4.2: Different current in transistor.

Here, $IE = IC + IB$, and the current gain $\beta = \frac{I_C}{I_B}$

Characteristics Curve: The characteristics of a transistor is measured by two characteristics curve. They are as follows –

a) Input characteristics curve.

b) Output characteristics curve.

Output Characteristics Curve: Output characteristics is defined by the set of curves between output current (IC) vs. output voltage (VCE) for the constant input current (IB). The curve has the following features –

- It has three regions namely Saturation, Active and Cut-off region.
- The rising part of the curve, where VCE is between 0 and approximately 1 volt is called saturation region. In this region the collector diode is not reversed biased.
- When the collector diode of the transistor becomes reverse biased, the graph becomes horizontal. In this region the collector remains almost constant. This region is known as the active region. In applications where the transistor amplifies weak radio and TV signal, it will always be operation in the active region.
- When the base current is zero, but there is some collector current. This region of the transistor curve is known as the cut-off region. The small collector current is called collector cut-off current.
- For different value of base current (IB) an individual curve can be obtained.

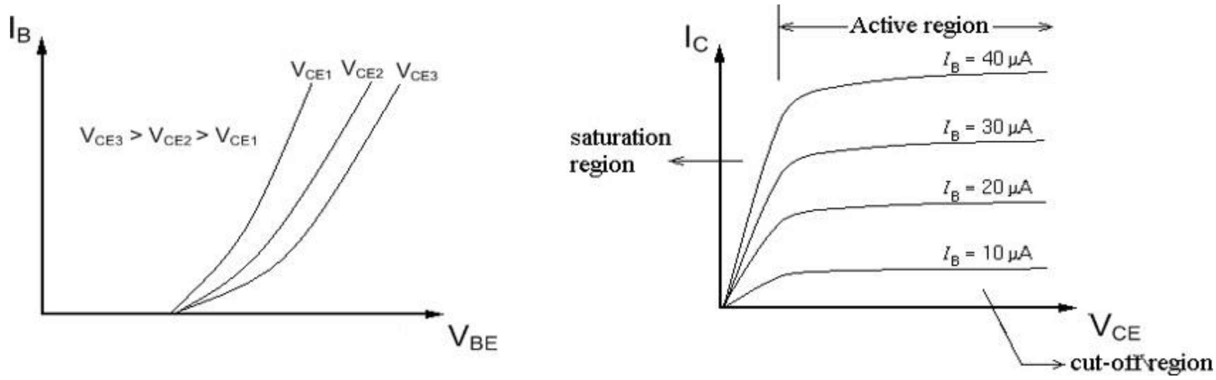

Figure 4.3: (a) Input Characteristic, (b) Output Characteristic of NPN transistor.

Procedure:

1. Connect the circuit using Proteus Simulation software as shown in the Figure 4.4. Use 4.7 KΩ as R.

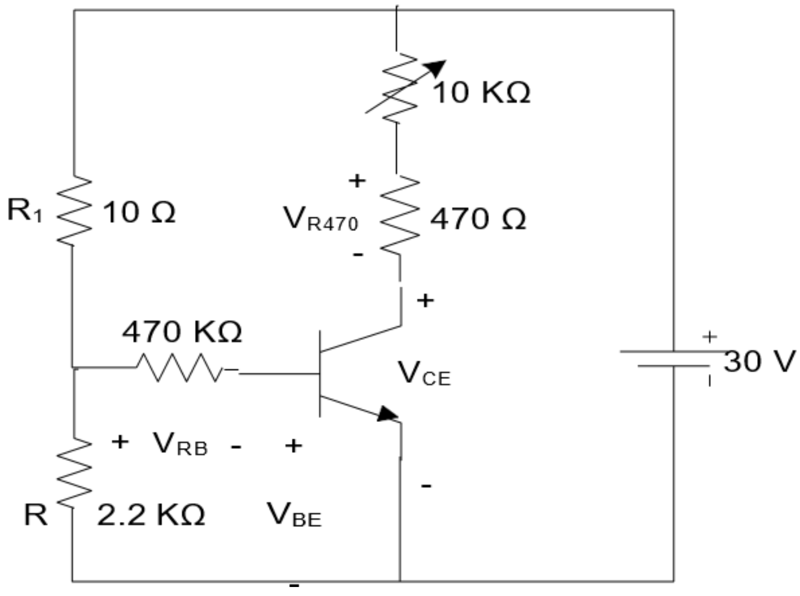

Figure 4.4: Experimental Circuit

2. Measure V_{RB} and calculate I_E using $I_E = V_{RB} / R_B$. (We will assume that IB to be constant for a particular setup at input.)
3. Measure the voltages of VCE and V_{R470}. And calculate I_C using $I_C = V_{R470}/R_{470}$. Take at least 6 reading by varying the POT.
4. Repeat step 1 to 4 with supply as $40V$ and $50V$.
5. Plot the graph of IC vs. VCE with necessary details. Show the different regions of operation
6. Find β for the three different condition.

Table 4.1: Data for I - V characteristics of transistor

V_{CC} **(V)**	**POT (Ω)**	$I_B = \frac{V_{RB}}{R_B}$ (μA)	$V_{CE}(V)$	$V_{R470}(V)$	$I_C = \frac{V_{R470}}{R_{470}}$ (mA)	$\beta = \frac{I_C}{I_B}$
	10K					
	8.5K					
	5K					
$30V$	3.5K					
	1K					
	500					
	10K					
	8.5K					
	5K					
$40V$	3.5K					
	1K					
	500					
	10K					
	8.5K					
$50V$	5K					
	3.5K					
	1K					
	500					

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EXPERIMENT : 5

TITLE : MULTISTAGE AMPLIFIER

OBJECTIVES : Upon completion the experiment, the student will be able to:

1. Identify the circuits of Multistage Amplifier
2. Analyze the operation of Multistage Amplifier

EQUIPMENTS / COMPONENTS:

1. Software Proteus (ISIS) Professional 8
2. Graph paper
3. Personal Computer (PC)

THEORY:

A Darlington Connection consists of cascaded emitter followers, typically a like in Figure 5.1. The base current of the second transistor comes from the emitter of the first transistor. Therefore, the current gain between the first base and the second emitter is:

$$\beta = \beta 1\ \beta 2$$

In the other words, the two transistors have a total current gain equal to the product of the individual current gains. The main advantage of a Darlington connection is the high input impedance looking into the base of the first transistor.

PROCEDURE :

1. Connect the circuit by using Proteus Simulation software as shown in Figure 5.1.

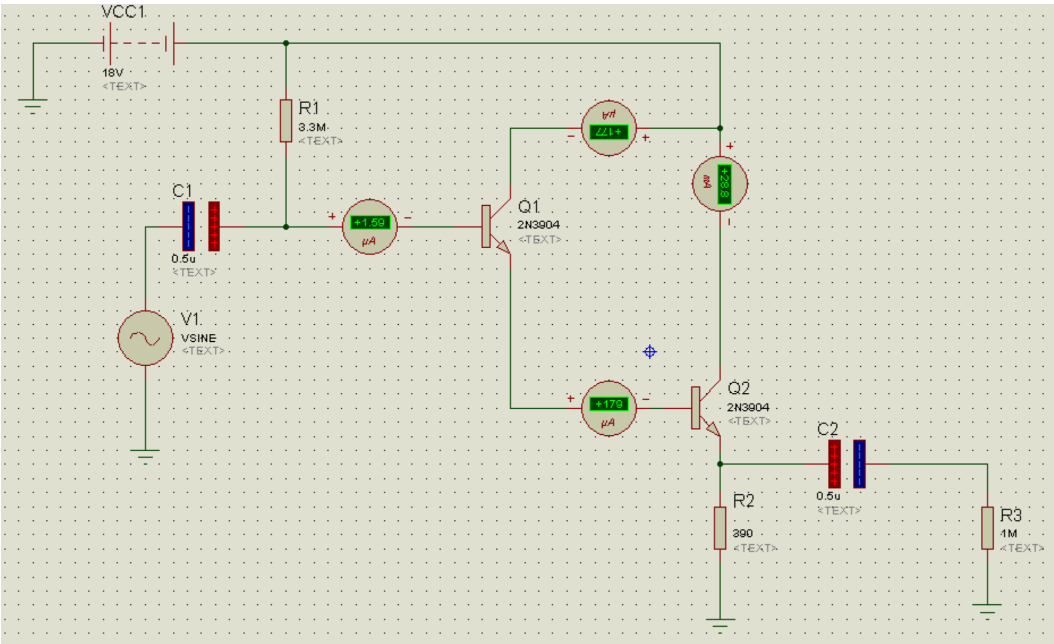

Figure 5.1

2. Use the value of R_1 = 3.3MΩ and R_2 = 390Ω as the value of resistors for Set A. Make sure connect the measurement equipment which is DC Ammeter on the circuit to get the reading. Run the simulation.
3. Record the value of I_B and I_C for first stage and second stage in Table 5.1.
4. Repeat step 2 by using the other set of R_1 and R_2 as in the Table 5.1.
5. Calculate the value of β_1 and β_2 by using formula, $\beta = I_C/I_B$. Then, get the total of β.
6. Discuss the results obtained in the discussion.

****All the calculation should be included in the repor**

RESULT :

Table 5.1

Resistor Sets	Current / Resistor	FIRST STAGE			SECOND STAGE			Calculate the total β, $\beta = \beta_1 \times \beta_2$
		I_B	I_C	β_1	I_B	I_C	β_2	
Set A	R1 = 3.3MΩ, R2 = 390Ω							
Set B	R1 = 6.8MΩ, R2 = 390Ω							
Set C	R1 = 3.3MΩ, R2 = 1kΩ							

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